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-04 Lenses

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PROVISIONAL SPECIFICATION.

2053

Improvements in Lenses.

We Dr. Heinrich Ludwig Hugo Schröder of 5 The Terrace Clapham Common in the County of Surrey Optician and John Stuart of The Hollies Clapham Common aforesaid Optician do hereby declare the nature of this invention to be as follows :—

This Invention relates to a new and improved lens or lenses designed for use where it is desirable to obtain plain images of large fields of view which shall be sharply defined up to the margin as for example is the case in photography.

According to my invention I combine two simple or uncorrected lenses of which the outer lens is plano-convex and is composed of a glass of high refractive index and low dispersive power the inner lens being plano-concave and being composed of a glass of lower refractive index but of the same or preferably of higher dispersive power.

The two lenses have their plane surfaces opposed to each other and are preferably cemented together the two curved surfaces being portions of concentric spheres.

By proper choice of the radii of these spherical surfaces and of the glasses used and of their thickness a corrected lens can be made to have a positive focus *i.e.* that is one to give a real image of an object receivable on a screen and the corrections of curvature and colour in such image may be made very perfect throughout a considerable angular distance from the axis. The ratio of the radii of the two concentric spherical surfaces will depend upon the refractive indices and dispersive powers of the glasses used.

The hereinbefore described arrangement may be slightly departed from either by the two external surfaces not being precisely concentric or the two internal surfaces precisely plane without departing from the substance of this invention but the best results will be obtained in the manner above described.

Corrected lenses made as above described may of course be used also as combinations.

Dated this 7th day of April 1888.

J. H. JOHNSON & Co.,
47, Lincoln's Inn Fields, London, W.C.,
Agents.

[*Price* 8*d*.]

359/794

COMPLETE SPECIFICATION.

Improvements in Lenses.

We, Dr. Heinrich Ludwig Hugo Schröder of 17 Althorp Road, Upper Tooting in the County of Surrey Optician and John Stuart of The Hollies, Clapham in the County of Surrey Gentleman do hereby declare the nature of this Invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

This Invention has for its object to provide a lens in which the errors of curvature of the image and colour correction incident to other lenses are overcome and this over a large field of view. Lenses made according to this Invention give a sharply defined image throughout the field which is of great advantage in most or all applications of lenses and especially so for photographic and other like purposes.

Hitherto all achromatic lenses (having either flat or other contact surfaces, that give a positive image have the convex radius shorter than the concave radius.

Now the distinctive feature of the lens according to this Invention is that by employing glasses combined as hereinafter described the radius of the convex surface is enabled to be longer than that of the concave surface and at the same time a positive image is still obtained. The convex and concave surfaces may thus be arranged to represent parts of two concentric spheres.

According to this Invention the objective is composed of a convexo plano lens made of glass of a high refractive power and relatively low dispersive power combined with a plano concavo lens made of a glass of lower refractive power than that of the glass of the convexo plano lens but of the same or higher dispersive power than that of the glass of the said convexo-plano lens. The inner or contact surfaces of these two lenses are placed together and preferably cemented the convexo plano lens forming the front portion of the objective.

By proper choice of the radii of the spherical surfaces of the lenses and of the glasses used and of their thicknesses an aplanatic lens can be made having a positive focus that is a lens giving a real image of an object receivable on a screen and having great flatness of field and suitable colour correction throughout a considerable angular distance from the axis. The ratio of the radii of the two concentric spherical surfaces will depend upon the refractive powers and dispersive powers of the glasses used as hereinafter more fully explained.

And in order that our said Invention may be fully understood we shall now proceed more particularly to describe the same and for that purpose shall refer to the several figures on the annexed sheet of drawings the same letters of reference indicating corresponding parts in both the figures.

Figure 1 of the accompanying Drawings is a transverse section of an objective made according to this Invention *a* being the convexo-plano lens of high refractive and low dispersive power and *b* being the plano concavo lens of lower refractive power and the same or higher dispersive power. The convex and concave external surfaces (marked respectively *e* and *d*) are portions of concentric or approximately concentric spheres having their centre at *f* and the plane internal surfaces are preferably cemented together at *c*.

In order to obtain a plane image throughout a large field of view the radii of the external surfaces (*e* and *d*) should have a certain ratio to each other dependant on the refractive and dispersive powers of the glasses used.

In practice it is found that the limits of the refractive powers of glass available for the front lenses of the improved objective are from about 1·59 to 1·61 the index being taken to be corresponding to the D line of the spectrum. Similarly the range of refractive powers for the glasses available for the back lens of the said objective ranges from about 1·50 to 1·53 the refractive index being as before that for the D line of the spectrum. It is to be understood that these figures are given as being what are considered the best with glass as now generally obtainable.

With the before named glasses the ratio of the refractive and dispersive powers which would produce the best radii so far as flatness of field and suitable colour correction of the image are concerned is given by the following tables.

TABLE No. 1.

	Dn=Index of Refraction relating to the convexo plano lens.			DN = Index of Refraction relating to the plano concave lens.
	1·59	1·60	1·61	
Dispersive Ratio = w.	0·916	0·904	0·891	1·53
	0·903	0·890	0·877	1·52
	0·889	0·876	0·864	1·51
	0·875	0·863	0·851	1·50

TABLE No. 2.

Ratio of the Concentric Curves = f

Dn = 1·59.

DN	w	f
1·53	0·916	1·072
1·52	0·903	1·086
1·51	0·889	1·100
1·50	0·875	1·115

Dn = 1·60.

DN	w	f
1·53	0·904	1·083
1·52	0·890	1·097
1·51	0·876	1·112
1·50	0·863	1·126

Dn = 1·61.

DN	w	f
1·53	0·891	1·094
1·52	0·877	1·109
1·51	0·864	1·123
1·50	0·851	1·138

Thus for example if the front or convexo-plano lens *a* have a refractive power of 1·61 for the line D in the spectrum and the back or plano concavo lens have a refractive power for the same line of 1·50 the ratio of the curves of the two spherical surfaces of the lenses (*e* and *d*) should be 1·138 in order that throughout the field of view the image may be plane with suitable colour correction.

Slight deviations may be made from the directions given above as for example by slightly departing from the plane internal surfaces (*c*) or from the concentricity of the external spherical surfaces (*e* and *d*) or from the ratio of the radii or dispersive and refractive powers of the two glasses (*a* and *b*) given by the above tables without departing from this Invention but we believe that by following the rules given above the best results will be obtained with glass at present obtainable.

With the aid of these tables the requisite ratios of the dispersive power appertaining to the refractive powers of the glasses used and also the requisite ratios of the radii of the lenses may be calculated by the ordinary method of interpolation. The objectives may be used singly as in Figure 1 or combined as in Figure 2 (*g* being the diaphragm between them).

Having now particularly described and ascertained the nature of our said Invention and in what manner the same is to be performed we declare that what we claim is.

1. The combination of a convexo plano lens made of glass of high refractive power and relatively low dispersive power with a plano concavo lens made of glass of lower refractive power and the same or higher dispersive power (the said lenses having plane or slightly curved contact surfaces and outer concentric or approximately concentric surfaces) to form an aplanatic lens or objective giving a positive image substantially as hereinbefore described with reference to the accompanying drawings.
2. The improved lens or objective hereinbefore described.

Dated this 7th day of February 1889.

J. H. JOHNSON & Co.,
Agents.

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